Vehicle Scheduling Problem in Terminals: a Review

Presenter:

Pei Wang, wangpei@cmhk.com
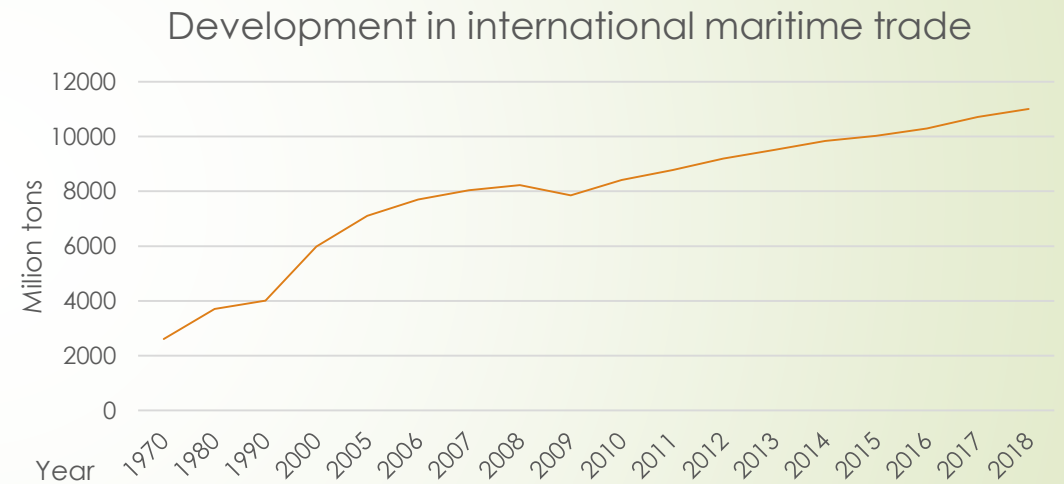
Catalog

- **Large proportion of international trade(90% of China's export trade)**

- **The rapid growth of maritime traffic**

Development in international maritime trade

- **The cost of maritime traffic is small (1/10 of rail transportation)**

Equipment in Terminal

Stacking crane

Quay crane

Load and unload containers

Container truck

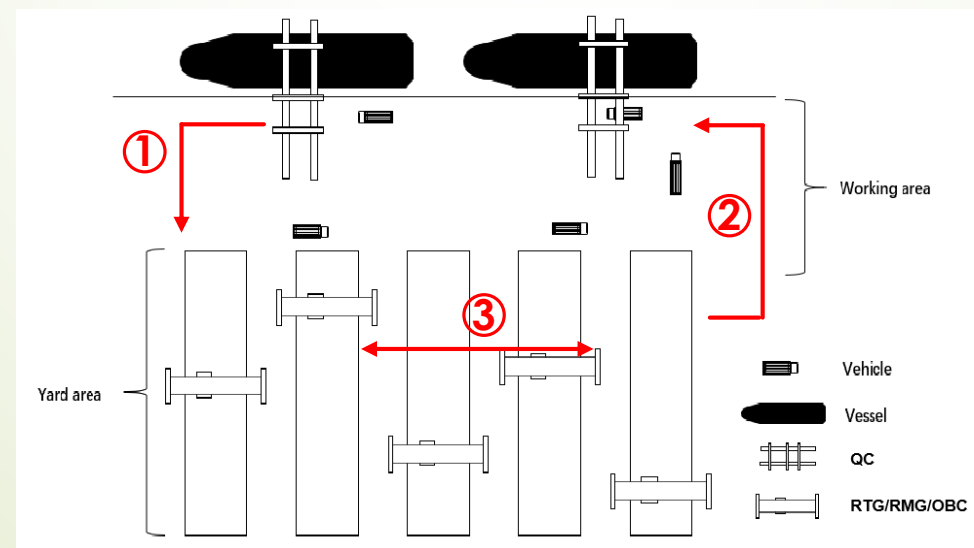AGV(Automated Guided Vehicle)

Transport containers

Layout of Terminal

Working area

Yard area

Vehicle

Vessel

QC

RTG/RMG/OBC

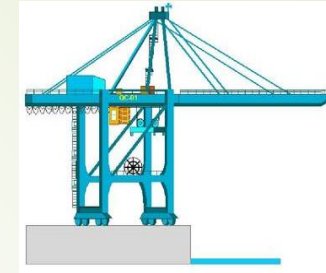**3 Transportation operations:**

① Ship unloading operation

② Ship loading operation

③ Yard transport operation

Target1   High efficiency operation of QC

Target2   Increase in vehicle turnover

                              Fleet Sizing Problem

Problems   Vehicle Dispatching Problem

                              Path Planning Problem

Description   Analyze optimal number of vehicles

Contradiction   Too few → delay of goods transportation
Too many → congestion, increase in vehicle cost

Analysis Method   Mathematic Model Analysis

Simulation Analysis

Fleet Sizing

Mathematic Model Analysis

Assumptions	Algorithms	Different situation
Vehicle speed Crane efficiency	Tabu algorithm Minimum flow algorithm	Static system Time-window

Strengths   Roughly estimate   Reference value

Weakness   Assumptions are too ideal   Hard to deal with random situations

Simulation Analysis

Target	Parameter	Simulation tools
Vehicle idle time Waiting time of other machines	Vehicle number	SIMUN ARENA SIMU8…

Strengths   More suitable for the real working environment

Weakness   Poor robustness

Vehicle Dispatching

Description Decide which task will be completed by which vehicle

Target Vehicle Travel Distance Crane Efficiency

Strategy
- Classic Rule Strategy
- Heuristic Strategy
- Machine Learning Strategy

Different situation Large fleet Multi-load vehicle dispatching

Classic Rule Strategy

Classic Rule Strategy

Greedy search based on basic target

Random Vehicle (RV)

Shortest Travel Distance (STD)

Longest Travel Distance (LTD)

Minimum Queue (MQ)

Network flow formulation

Fuzzy theory with multiple –criteria

Method combined with layout

Strengths   Fast calculation   Easy to adjust parameters

Weakness   Poor robustness   Bad performance on large-scale problems

Heuristic Strategy

Heuristic Strategy

Search algorithm improvement

Genetic Algorithm   Immune Algorithm

Combine with other algorithm

Mix-integer programming with heuristic algorithm

Multi-objective evolutionary algorithm (MOEA)

Fuzzy-theory with Ant Colony Optimization and Genetic Algorithm (HACOGA)

More factors are concerned

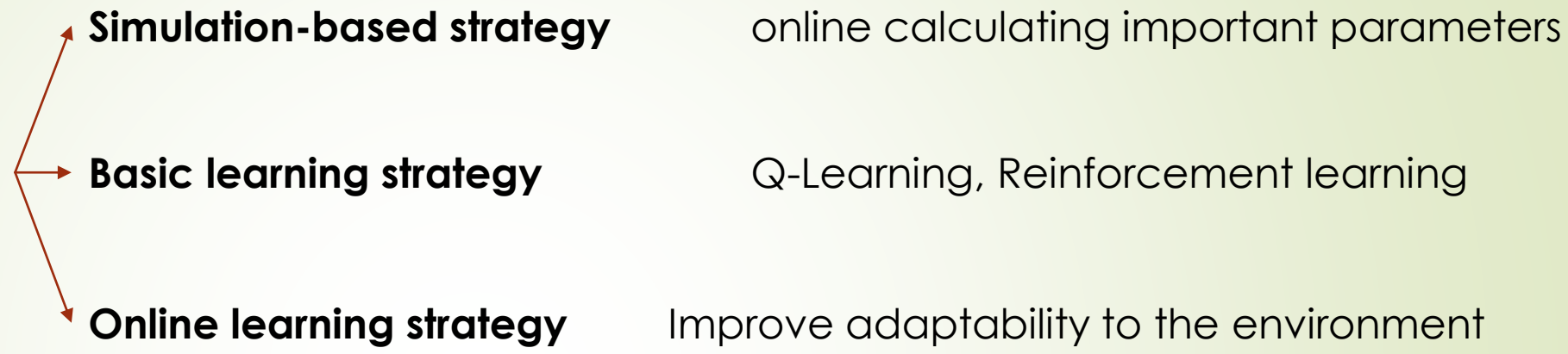Delay of container transports   Vehicle pool method

Strengths   Good performance on large-scale problems / complex calculation

Weakness   Poor robustness

Machine Learning

Machine Learning Method

Simulation-based strategy   online calculating important parameters

Basic learning strategy   Q-Learning, Reinforcement learning

Online learning strategy   Improve adaptability to the environment

Strengths   Good robustness

Weakness   High data requirements

Description   Find best paths for vehicles

Traditional methods
&
their improvement

Graph search strategy: A* , Dijsktra

Real-time updating for edges' weight

Jump point search

Angle evaluation

Combine A* with visibility diagram planning

Configuration space algorithm (CSA)

Artificial potential field (APF)

Dynamic artificial potential field

Speed factor is added

virtual obstacle

Associate target

Weakness   Hard to balance computation time and performance

Intelligent methods

Fuzzy logic control

Combined with artificial potential field

Use PSO algorithm to optimize the threshold

Minimum-risk approach

Virtual force field technique

Genetic algorithm (GA)

Adaptive multi-object genetic algorithm (AMOGA)

Quantum genetic algorithm

Neural network algorithm

Multi-scale map method

Wave expansion neural network (WENN)

Weakness   Tendency of falling into local minima

Fleet sizing problem

Ideal assumptions

Poor versatility

Combine simulation and theoretical basis

Vehicle dispatching problem

Few studies directly focus on the efficiency of QC

Data driven method

Simulation method

Path planning problem

Few researches on online path change

Balance computation time & performance

Faster computation

Dynamic solution

THANKS!

Q&A

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